SUGAR AND SUGAR DERIVATIVES IN RESIDUES PRODUCED FROM THE UV IRRADIATION OF ASTROPHYSICAL ICE ANALOGS. M. Nuevo[1,2], S. A. Sandford[1], and G. Cooper[1], [1]NASA Ames Research Center, MS 245-6, Moffett Field, CA 94035, USA, [2]BAER Institute, 625 2nd St., Ste. 209, Petaluma, CA 94952, USA; E-mails: michel.nuevo-1@nasa.gov; scott.a.sandford@nasa.gov.

Introduction: A large variety and number of organic compounds of prebiotic interest are known to be present in carbonaceous chondrites. Among them, one sugar (dihydroxyacetone) as well as several sugar acids, sugar alcohols, and other sugar derivatives have been reported in the Murchison and Murray meteorites **[1]**. Their presence, along with amino acids, amphiphiles, and nucleobases **[2-6]** strongly suggests that molecules essential to life can form abiotically under astrophysical conditions.

This hypothesis is supported by laboratory studies on the formation of complex organic molecules from the ultraviolet (UV) irradiation of simulated astrophysical ice mixtures consisting of H_2O, CO, CO_2, CH_3OH, CH_4, NH_3, etc., at low temperature. In the past 15 years, these studies have shown that the organic residues recovered at room temperature contain amino acids **[7-9]**, amphiphiles **[4]**, nucleobases **[10-13]**, as well as other complex organics **[14-16]**.

However, no systematic search for the presence of sugars and sugar derivatives in laboratory residues have been reported to date, despite the fact that those compounds are of primary prebiotic significance. Indeed, only small (up to 3 carbon atoms) sugar derivatives including glycerol and glyceric acid have been detected in residues so far **[14-16]**.

Results: In this work, we carried out a systematic search for sugars and sugar-related compounds in organic residues produced from the UV irradiation of simple H_2O:CH_3OH (2:1 and 5:1) ices, and show that they contain several sugar alcohols up to 5 carbon atoms long, as well as sugars and sugar acids up to 4 carbon atoms long **[17]**. Results are briefly compared with meteoritic data **[1]**.

References: [1] Cooper G. et al. (2001) *Nature*, *414*, 879–883. [2] Kvenvolden K. et al. (1970) *Nature*, *228*, 923–926. [3] Cronin J. R. and Pizzarello S. (1997) *Science*, *275*, 951–955. [4] Dworkin J. P. et al. (2001) *Proc. Natl. Acad. Sci.*, *98*, 815–819. [5] Folsome C. E. et al. (1971) *Nature*, *232*, 108–109. [6] Stoks P. G. and Schwartz A. W. (1979) *Nature*, *282*, 709–710. [7] Bernstein M. P. et al. (2002) *Nature*, *416*, 401–403. [8] Muñoz Caro G. M. (2002) *Nature*, *416*, 403–406. [9] Nuevo M. et al. (2008) *OLEB*, *38*, 37–56. [10] Nuevo M. et al. (2009) *Astrobiol.*, *9*, 683–695. [11] Nuevo M. et al. (2012) *Astrobiol.*, *12*, 295–314. [12] Materese C. K. et al. (2013) *Astrobiol.*, *13*, 948–962. [13] Nuevo M. et al. (2014) *ApJ*, *793*, 125 (7 pp.). [14] Nuevo M. et al. (2010) *Astrobiol.*, *10*, 245–256. [15] de Marcellus P. et al. (2011) *Astrobiol.*, *11*, 847–854. [16] de Marcellus P. et al. (2015) *Proc. Natl. Acad. Sci.*, *112*, 965–970. [17] Nuevo M. et al., *in prep*.

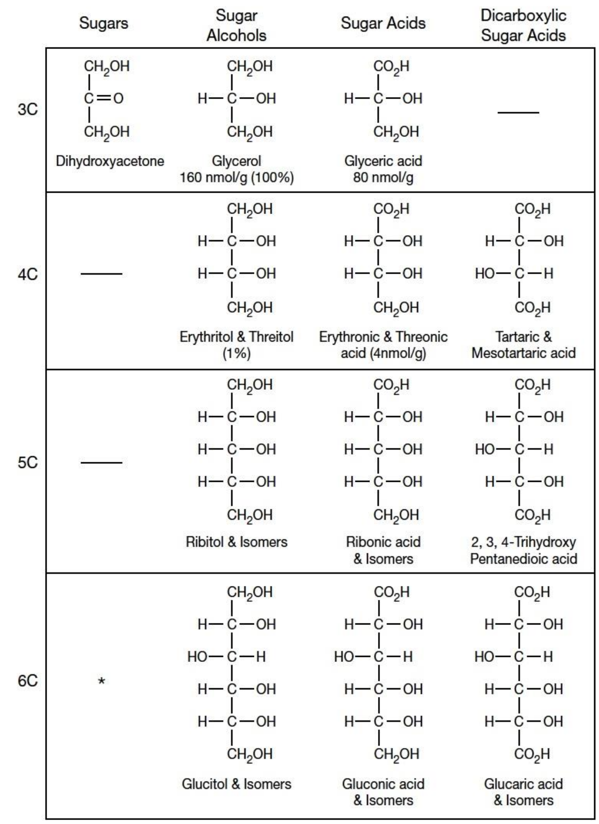

Fig. 1. *Sugars, sugar alcohols, sugar acids, and dicarboxylic sugar acids detected in the Murchison and Murray meteorites (adapted from Ref.* ***[1]****). These compounds were searched for in our laboratory residues produced from the UV irradiation of* H_2O:CH_3OH *ice mixtures.*